Grid Investments to Support FERC Order 2222

How Distribution Utilities Will Deploy Grid Technologies to Enable Consumers to Participate in Emerging DER Aggregation Markets

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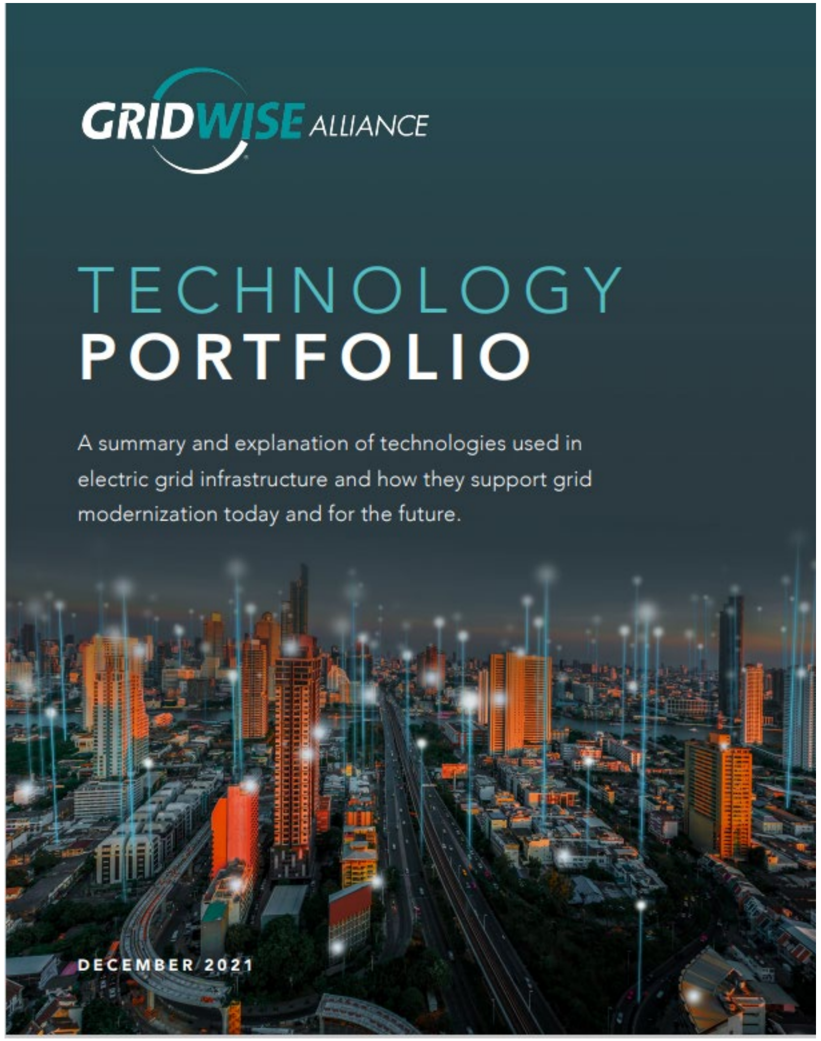
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TECHNOLOGY
PORTFOLIO

A summary and explanation of technologies used in electric grid infrastructure and how they support grid modernization today and for the future.

DECEMBER 2021

GWA_GridWiseTechnologyPortfolio_Final.pdf

DESIRED OUTCOMES

DECARBONIZED POWER SUPPLY
AFFORDABLE ENERGY
BENEFICIAL ELECTRIFICATION

RELIABLE DELIVERY
RESILIENT SYSTEM
CUSTOMER CHOICE

Functional Areas

- Integrated Planning
- System Visibility
- Real-time Operation
- Consumer & Energy Services Engagement
- Emerging Grid Architecture

Technology Examples

- Automatic DER interconnections
- Interdependency coplanning
- Integrated distribution and transmission planning
- Synchrophasors
- Advanced distribution management systems
- Volt-Var optimization
- Home energy management
- Distributed energy resource management systems
- Networked microgrids
- Advanced metering infrastructure systems

Enabling Technologies

- Quantum computing
- Internet of Things
- Physical & cybersecurity protocols
- Open source and data standards
- Blockchain
- Data science
- Machine learning
- Cloud Services

EXAMPLE TECHNOLOGY | Advanced Distribution Management System

WHAT IT IS?

An advanced distribution management system (ADMS) is a software platform that digitizes and integrates numerous utility operational and monitoring systems including SCADA systems, outage management systems (OMS), existing distribution management systems (DMS), and workforce management and data visualization. It provides a comprehensive digital representation of the condition of the distribution network and supports optimal management of DERs and integration with utility tools for billing and data collection.

WHY IS IT ESSENTIAL FOR A MODERN GRID?

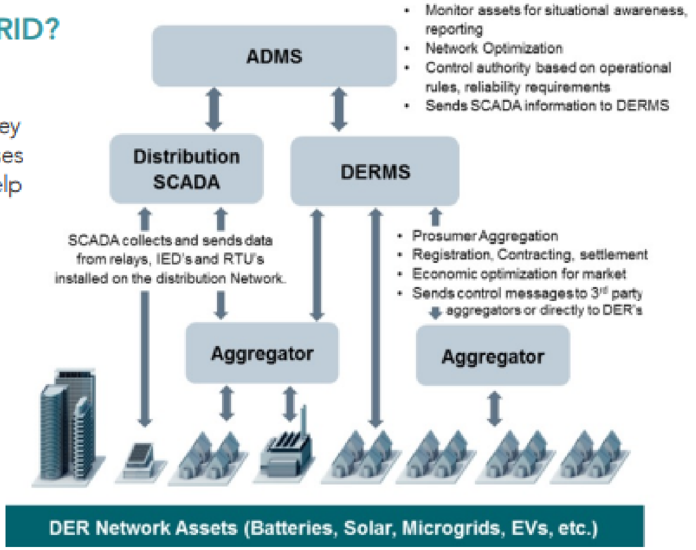
With the increase in DERs connecting the the grid, from solar PV to electric vehicles, ADMS systems are considered increasingly essential to the future of the utility business. They support a utility in transitioning from manual, paper processes to digitized, automatic process that use real-time data to help better integrate renewables and improve grid efficiency.

WHERE IS IT LOCATED?

ADMS is not a physical entity but a software platform that is installed and run from a utility control center.

HOW MATURE IS THE TECHNOLOGY?

Mid-stage development, ready for scaling | While early pilots of ADMS date back over a decade, the technology is still evolving and is only lightly adopted. Research into ADMS systems by national laboratories is underway and vendors continue to develop products for adoption by utilities.



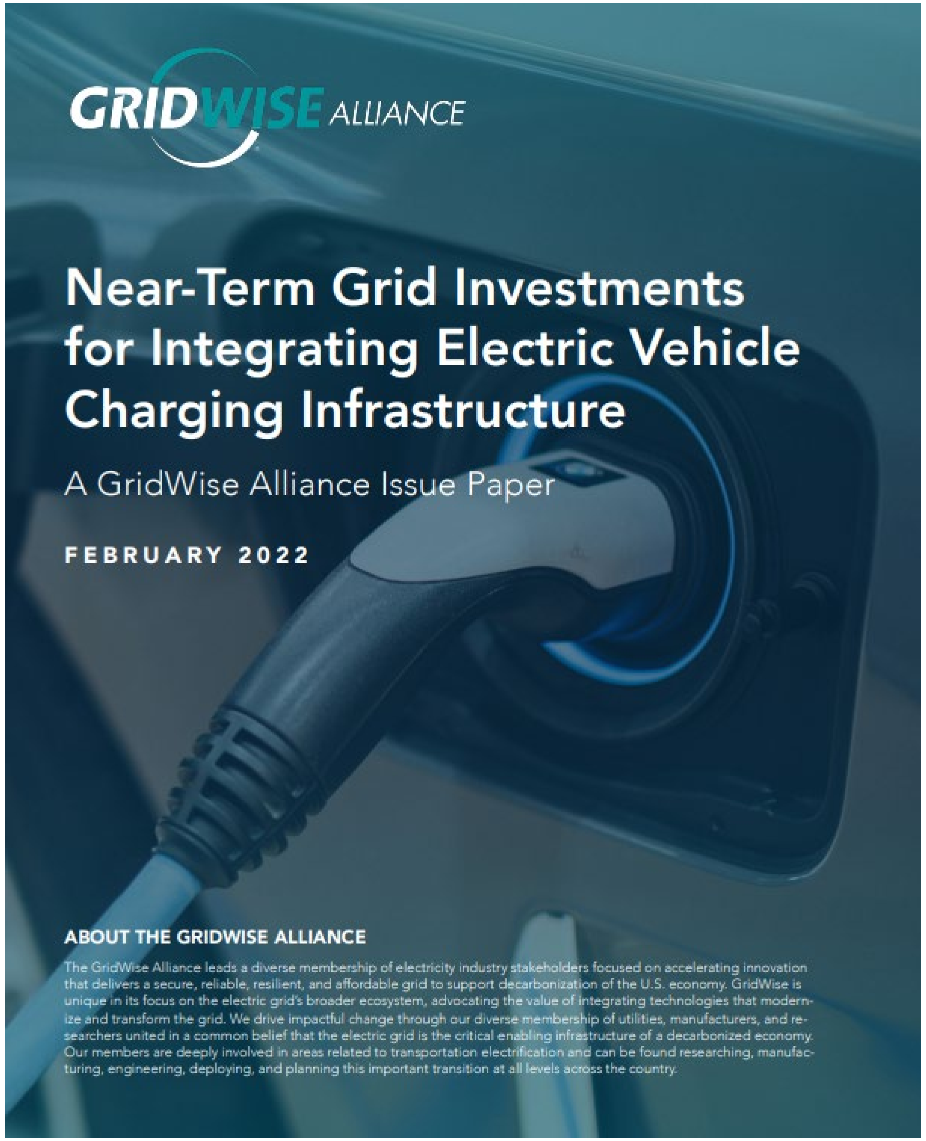
ADMS has a complete view of the operating network.
Source: Powergrid International.

EXAMPLE: RESEARCH TEST BED

For several years now, the National Renewable Energy Laboratory (NREL) has operated a test bed to serve as a vendor-neutral evalutation platform for advanced grid controls implemented on ADMS platforms. Multiple use cases have gone through evaluation, and it continues to research ADMS capabilities. See more on this effort here.

FOR MORE INFORMATION

- U.S. DOE. Voices of Experience: Insights into Advanced Distribution Management Systems. 2015.
- National Renewable Energy Laboratory. Advanced Distribution Management Systems. 2020.
- U.S. DOE. Advanced Distribution Management Systems Testbed Development. 2020.



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Near-Term Grid Investments for Integrating Electric Vehicle Charging Infrastructure

A GridWise Alliance Issue Paper

FEBRUARY 2022

ABOUT THE GRIDWISE ALLIANCE

The GridWise Alliance leads a diverse membership of electricity industry stakeholders focused on accelerating innovation that delivers a secure, reliable, resilient, and affordable grid to support decarbonization of the U.S. economy. GridWise is unique in its focus on the electric grid's broader ecosystem, advocating the value of integrating technologies that modernize and transform the grid. We drive impactful change through our diverse membership of utilities, manufacturers, and researchers united in a common belief that the electric grid is the critical enabling infrastructure of a decarbonized economy. Our members are deeply involved in areas related to transportation electrification and can be found researching, manufacturing, engineering, deploying, and planning this important transition at all levels across the country.

GWA_22_NearTermGridInvestmentsEVChargingInfra_Final.pdf (gridwise.org)

Real-time Operation

BACKGROUND

At both the transmission and distribution level, the grid needs systems and technologies that can act automatically on system data and deliver the increased load associated with growing EV adoption. Electric vehicles will be a source of two-way power flow on the grid once vehicle-to-grid functionality is implemented and upgrades will need to occur at the substation level and throughout the system to prepare the grid for this reverse power flow. Several technologies available today can monitor and respond to grid conditions, especially important as EVs continually connect and disconnect from the grid, and are capable of immediately correcting operational problems related to voltage, current, frequency, and outages.

NEAR-TERM INVESTMENT NEED	REASONING
Voltage regulation technologies	Voltage regulation technologies offer greater visibility and control into real-time, localized usage of electric load. Electric load and quality fluctuate during EV charging or when vehicle-based stored energy is passed back to the grid. Proper siting of this technology allows the utility insights into the behaviors and patterns of an EV charging station while managing power quality. Smart inverters are one example of a voltage regulation technology, though they also provide other services including frequency regulation and DC-AC current conversion. Another type of voltage regulation technology is volt-VAR regulation, which regulates and optimizes power flow on the distribution system.
Energy storage systems	Energy storage, when co-located with EV charging infrastructure, could play a role in mitigating peak electricity demand of highway charging stations and ultimately lower the cost of charging for consumers. It may not be necessary to have storage at all charging sites however, so supporting early planning efforts around charging infrastructure and technology needs is important.
Distributed energy resource management systems (DERMS)	DERMS can both monitor and control DERs placed throughout the distribution system, such as EVs. At minimum, DERMS provide a way to make the load from EVs visible to the broader system. Fully implemented DERMS will be a key component to supporting advanced vehicle-to-grid functionality.

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Outline

- FERC Order 2222 requirements
- GridWise maturity phase model
- DER aggregation process
- Aggregator grid functions and supporting Technologies
- Other considerations
- Technology one-pagers

Scope of FERC Order 2222

- **ISOs must allow aggregations of DERs to participate in ISO markets**
  - ✓ To meet minimum size (≥100 kW) & other requirements
  - ✓ To provide services for which they qualify technically
  - Includes capacity, energy, & ancillary services markets

- **DERs include:**
  - ✓ Storage (electric & thermal), gensets, distributed solar & wind, demand response, energy efficiency, EVs+chargers, etc.
  - ✓ Located on distribution system or behind customer meter
  - ✓ Aggregations can be homogeneous or heterogenous as to DER types

- **Applies to ISOs/RTOs, flows down to their LSE's (distribution utilities)**
  - ✓ Small utilities may opt-out (<4 million MWh/yr → ~350,000 population)

FERC 2222 Implementation

- **ISOs must submit proposed participation rules to FERC, including:**
  - ✓ Metering & telemetry requirements
  - ✓ Information & data requirements
  - ✓ Coordination of ISO, aggregators, distribution utilities, & retail regulators
  - ✓ Locational requirements, distribution factors, bidding parameters

- **FERC's implied intent is consistent treatment* of bulk resources & DERs**
  - ✓ Among DER types
  - ✓ Between aggregated & individual DERs
  - ✓ Across DERs, bulk generators, & LSE loads

* recognizing it may not be perfectly achievable in practice

- **Many ISOs modifying pre-existing participation rules to comply**
  - ✓ Regional differences are likely inevitable

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FERC Allows Restrictions on Aggregated DERs

ISOs shall include appropriate restrictions, if narrowly designed to avoid counting/compensating services from DERs more than once, e.g.:

- Bids offered into market & not added back to a LSE’s load profile
  - ✓ *Double-counts* as both load reduction & supply
  - ✓ DERs that are included in a retail program to reduce a LSE’s obligation to purchase services from the ISO market
- Providing same service twice:
  - ✓ In multiple aggregations
  - ✓ As aggregation AND as individual resource
  - ✓ As aggregation AND in retail load reduction program
- Can limit size of individual DERs in aggregations, e.g. ≤ 100 kW
  - ✓ May prefer to account for large resources individually because of reliability concerns
- Can declare energy efficiency ineligible for energy or ancillary services markets
  - ✓ Technically incapable of being dispatched, metered, or telemetered

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Technical and Process Implications of FERC 2222

1. **Prohibits double-counting & double-rewarding DER response:**
   - ➢ LSE must provide gross load forecast & demand bids to ISO energy markets adjusted for net output of aggregated DERs
   - ➢ Much more sophisticated forecasting algorithms required
   - ➢ Communications w/ aggregators re bids offered & accepted
   - ➢ LSE for adjusted gross (not metered) consumption

2. **DER participation in ISO markets is at wholesale prices, so:**
   - ➢ Retail bills reflect gross consumption, adjusted for net output of aggregated DERs

Technical and Process Implications of FERC 2222 (cont.)

3. **Items 1 & 2, together, likely require:**
   - Submeters for distributed generation & storage
   - M&V algorithms based on estimated baseline for demand response & EV charging

4. **Capacity market rules require DERs to bid into wholesale energy market**
   - DERs can’t offer to commit same capacity in both wholesale market & distribution level
   - Inhibits utility from relying on them to provide local, distribution services
   - Cannot locally re-dispatch DERs with bids not accepted at wholesale
     w/o disrupting LSE load forecast & bid quantities

Grid Technologies To Enable Participation

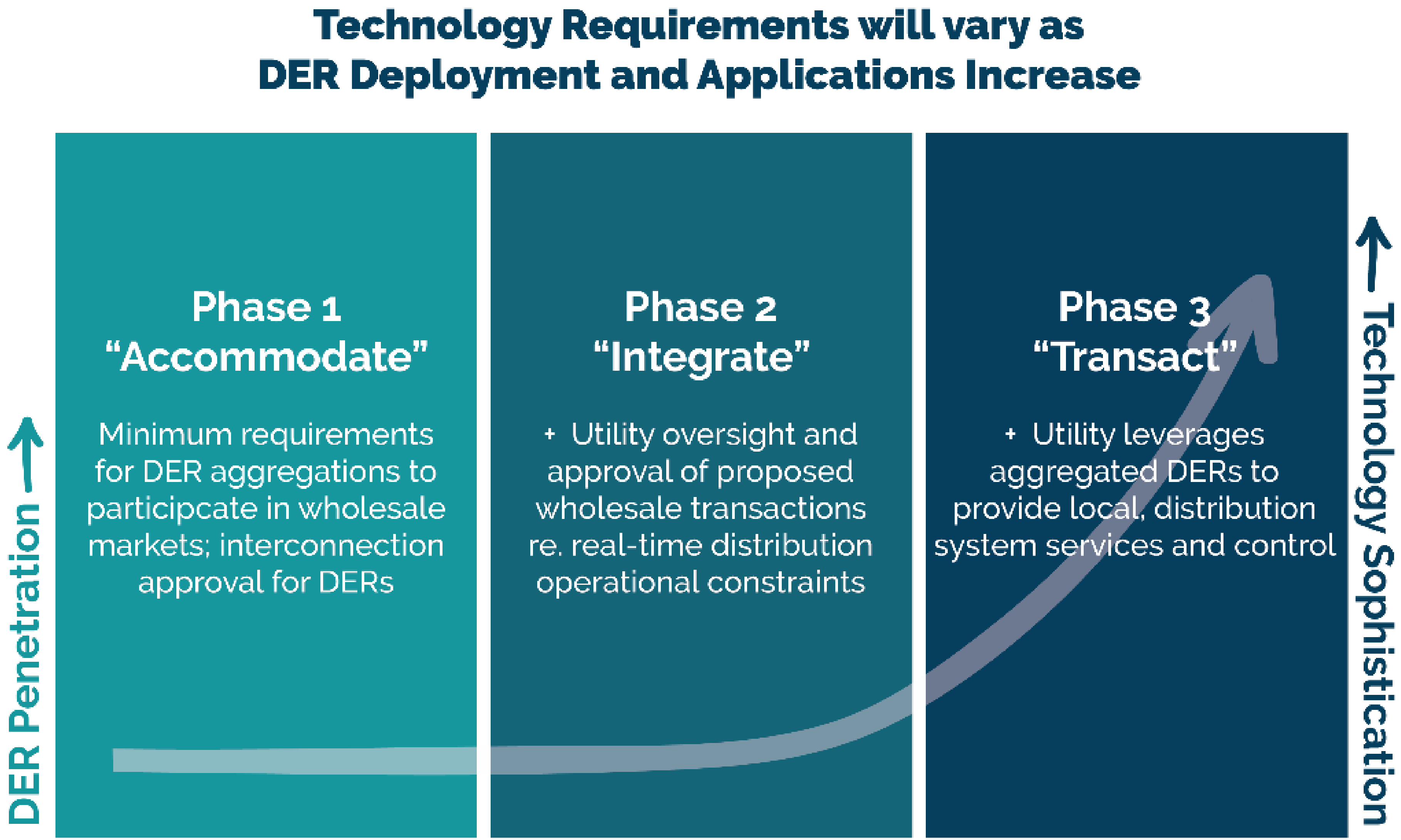


Figure 2: GridWise Alliance Maturity Phase model for adopting FERC 2222 supportive technology.

DER Aggregation Process, Benefits, & Challenges

DER Aggregation Process

ID and qualify DER units
↓
Acquire customers
↓
Establish system communications
↓
Aggregate and manage DER
↓
Participate in markets
↓
Conduct reporting and settlement

- **Enables control of multiple DERs as single entity providing demand response, ancillary services, and energy**
- **Requires software and communication technologies to dispatch, manage, and monitor performance real-time**

Benefits

- Reduced energy costs
- Improved grid reliability
- Reduced carbon emissions
- Provides a new revenue stream for DER owners
- Promotes the integration of renewable energy

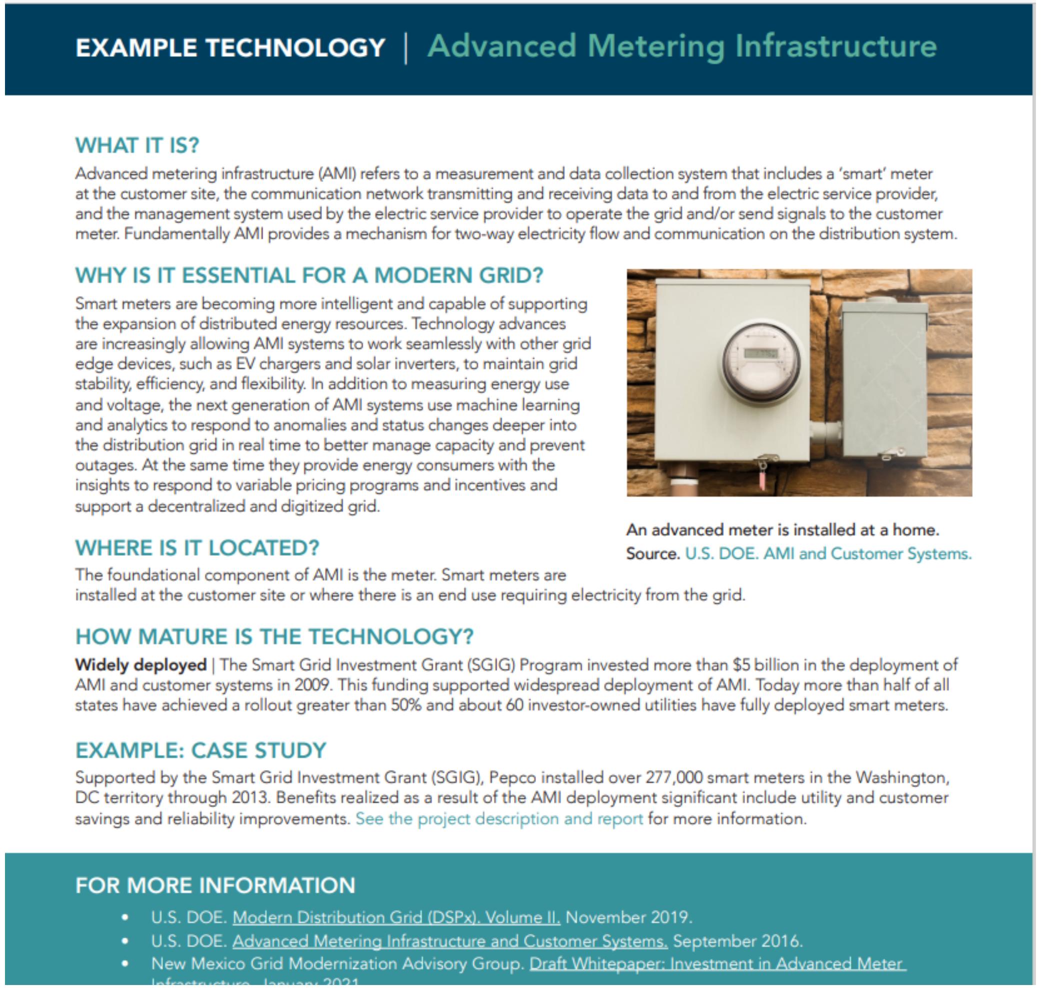
Challenges

- Lack of standardization
- Lack of clarity around DER ownership and control
- Disparate approaches to FERC Order 2222 implementation

Grid Functions Enabled by Supporting Technologies

Connecting DERs to the wholesale market requires advanced technologies across functional areas. Some technologies will be deployed by utilities, some by aggregators.

Technology One-Pagers


EXAMPLE TECHNOLOGY | Advanced Metering Infrastructure

WHAT IT IS?

Advanced metering infrastructure (AMI) refers to a measurement and data collection system that includes a 'smart' meter at the customer site, the communication network transmitting and receiving data to and from the electric service provider, and the management system used by the electric service provider to operate the grid and/or send signals to the customer meter. Fundamentally AMI provides a mechanism for two-way electricity flow and communication on the distribution system.

WHY IS IT ESSENTIAL FOR A MODERN GRID?

Smart meters are becoming more intelligent and capable of supporting the expansion of distributed energy resources. Technology advances are increasingly allowing AMI systems to work seamlessly with other grid edge devices, such as EV chargers and solar inverters, to maintain grid stability, efficiency, and flexibility. In addition to measuring energy use and voltage, the next generation of AMI systems use machine learning and analytics to respond to anomalies and status changes deeper into the distribution grid in real time to better manage capacity and prevent outages. At the same time they provide energy consumers with the insights to respond to variable pricing programs and incentives and support a decentralized and digitized grid.

An advanced meter is installed at a home.
Source. U.S. DOE. AMI and Customer Systems.

WHERE IS IT LOCATED?

The foundational component of AMI is the meter. Smart meters are installed at the customer site or where there is an end use requiring electricity from the grid.

HOW MATURE IS THE TECHNOLOGY?

Widely deployed | The Smart Grid Investment Grant (SGIG) Program invested more than $5 billion in the deployment of AMI and customer systems in 2009. This funding supported widespread deployment of AMI. Today more than half of all states have achieved a rollout greater than 50% and about 60 investor-owned utilities have fully deployed smart meters.

EXAMPLE: CASE STUDY

Supported by the Smart Grid Investment Grant (SGIG), Pepco installed over 277,000 smart meters in the Washington, DC territory through 2013. Benefits realized as a result of the AMI deployment significant include utility and customer savings and reliability improvements. See the project description and report for more information.

FOR MORE INFORMATION

- U.S. DOE. Modern Distribution Grid (DSPx), Volume II. November 2019.
- U.S. DOE. Advanced Metering Infrastructure and Customer Systems. September 2016.
- New Mexico Grid Modernization Advisory Group. Draft Whitepaper: Investment in Advanced Meter Infrastructure. January 2021.

- **About This Technology**
- **Use in the Modern Grid**
- **Physical Location**
- **Changes Needed to Support FERC Order 2222**
- **Technology Dependencies**
- **Case Studies**

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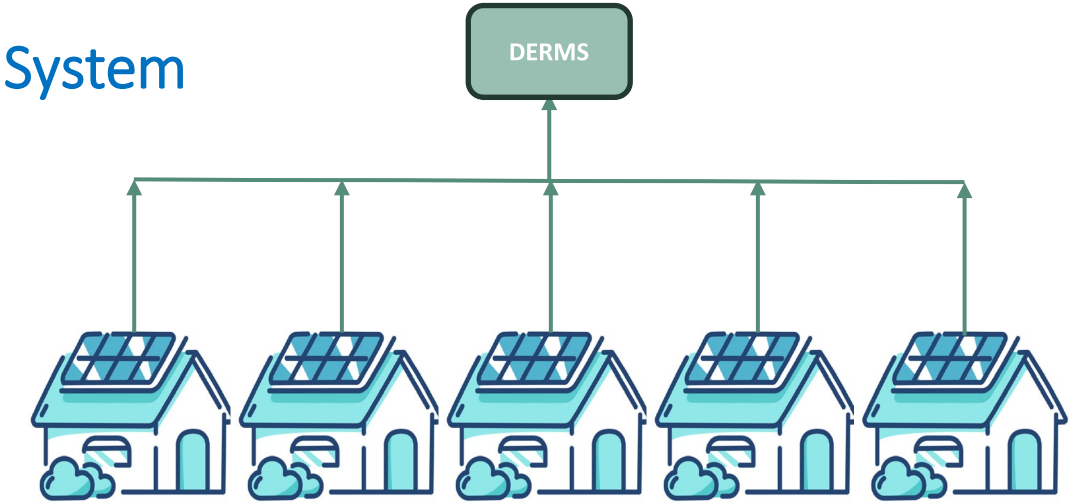
Example Technologies to Support FERC Order 2222

Distributed Energy Resources Management System



Communications (Fiber + FAN)

- About This Technology
- Use in the Modern Grid
- Physical Location
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Grid Investments to Support FERC Order 2222
QUESTIONS?